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To cite this article: O Ponomareva *et al* 2021 *IOP Conf. Ser.: Mater. Sci. Eng.* **1047** 012003

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# Date preparation module of automated metallurgical products production system

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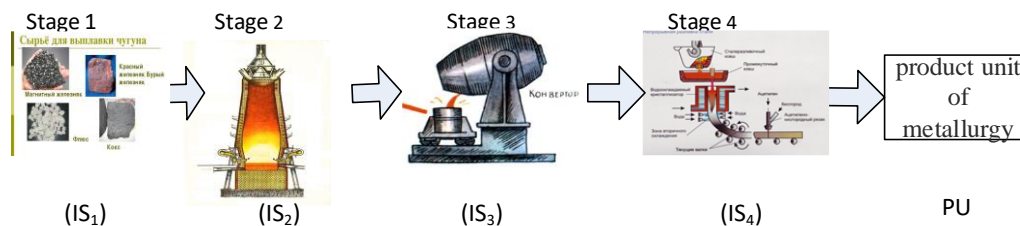
**Abstract.** The article discusses the data preparation module of the automated metallurgical production system, which provides data to obtain from heterogeneous sources (ASS, CIS, MES, ERP systems), convert heterogeneous data into a convenient form for subsequent storing, configure the converting rules and output heterogeneous data relevant to the query. Proposed components of the data preparation module: logical structure of data preparation module, algorithm of data preparation module operation, the link with simulation modeling and other modules, the list of technical equipment. A fragment of the interface of the data preparation module is being converted.

## 1. Introduction

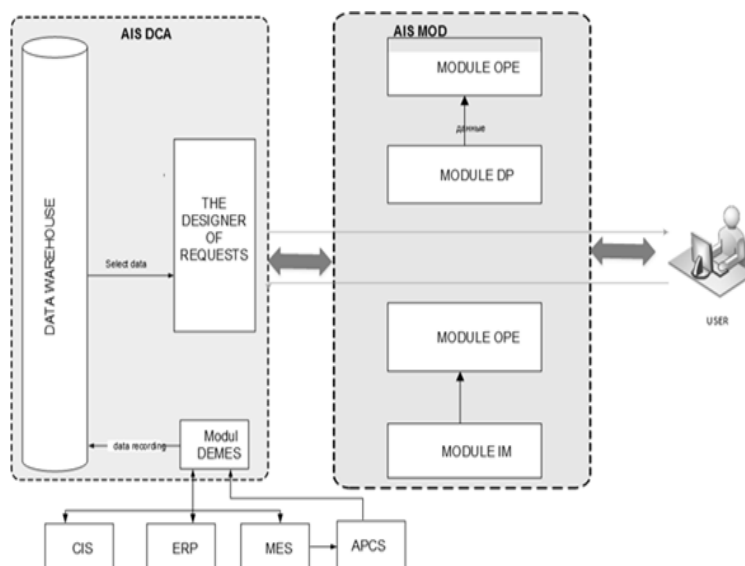
The simplified technological scheme of metallurgical production (MP) is shown in figure 1. The management of its life cycle usually uses different ASU TP, corporate information systems (CIS), MES, and ERP systems, which also provide accumulation and storage of various information about a production unit (PU), parameters of technological equipment and business processes within each MP limit in corresponding databases (DB). The quality assurance of MP products and regular improvement of MP business processes needs to extract and jointly analyse the information contained in various databases [1].

"Automated system for the production of metallurgical products" (AS MPP) was developed to automate the solution to this problem. The system includes two subsystems: "Automated information system of data collection and analysis" (AIS DCA) and automated information system of mathematical data processing and business process modeling (AIS MDP), which provides the collection of data in single data storage (DS) for each MP production unit and access to the information about the UP, the block diagram is shown in figure 2 [2,3].





**Figure 1.** Simplified scheme of MP technological process.



**Figure 2.** Block diagram of the automated metallurgical production system (AS MPP).

Figure 2 shows that data storage is AS MPP core which fulfills the following functions:

- record a large amount of heterogenous data, at least 7 TB;
- provide data about technological processes;
- obtain statistical data on DS operation;
- store the results of MP business processes modeling;
- backup.

Data storage solves the following tasks:

- centrally stores AS MPP data;
- executes analytical queries via "Query design" module (QD);
- stores the results of MP business processes modeling and extract them from DS if necessary;
- backups of AS MPP data.

Scientifically based technological solutions used in the development of AS MPP data storage are described in [4,5].

In the present article, the authors describe module data preparation (DP), which provides data performance extracted by QD from data storage in the form required by the module of creating models of enterprise processes (CMP) and specified by the user for analysis of MP data.

## 2. Functions, logical structure, the algorithm of DP module work

DP module is designed to fulfill the following functions:

- obtain data selection generated by a query from QD module;
- set the rules for processing of data selection using the graphical tool of data processing rule creation;
- joint operation of multiple DP modules while integrating into a unified programming interface of DP modules (modules of data source, data processing, analysis and verification);
- long-term storage of user settings of the data preparation process in data storage;
- analysis, verification, and conversion of data selection according to a given set of rules;
- missed data recovery on the analysis of accumulated statistic data;
- analysis of MP parameters based on machine learning methods.

### 2.1. Logical structure of DP module

DP module software, written in Java, Java Platform, Enterprise Edition, version 6; PL/SQL (built-in programming language of Oracle Database), is divided into the following structural parts:

- The subsystem of converting an object representation of a rule set of (DP handler modules) and links between them (DP task) into an implemented form (JSON text format) to retain in AIS MDP data storage and back. (The tool of setting data processing rules fulfills a graphical mode of creation, execution and viewing rules by embedding handler modules (HM) into the required data stream.)
- The subsystem of DP tasks.
- The subsystem of long-term storage, which is responsible for previously solved DP tasks in AIS MDP data storage.
- The tool for setting rules of data processing that provides a user interface for visual creation of a data conversion sequence, analysis and verification, and this tool implements a graphical user interface.
- The module of automated DP testing provides automated work accuracy testing in mathematical algorithms of analysis modules.
- Deployment subsystem creates the necessary Oracle table structures in AIS MDP data storage to retain objects prepared by the long-term storage subsystem.

### 2.2. Algorithm of DP module operation

The DP module is implemented in accordance with the Pipeline architectural template. The algorithm of operation and its scheme are presented below (figure 3).

Figure 3 shows that DP module is transmitted the name of a previously saved DP task or its text and DP module obtains an object "DP task" from data storage or creates it from the text. Next, the task execution subsystem is initialized and it fulfills the following:

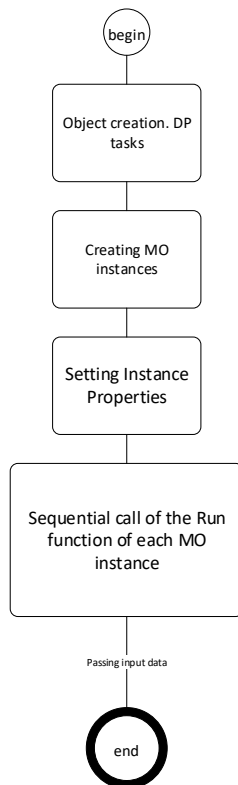
- matches the tasks used in an object and HM identifiers to their program implementations;
- creates samples of program implementations of multiple definition (MD) for each MD defined in the object;
- transmits MD samples their settings
- consistently (in accordance with the associations defined in the task) launches each MD sample until all MD are completed.

The end of the execution is the call completion of Run method of every MD. After completing the task, the subsystem passes control back to the DP module. Converted data by accessing the data property of each MD modules.

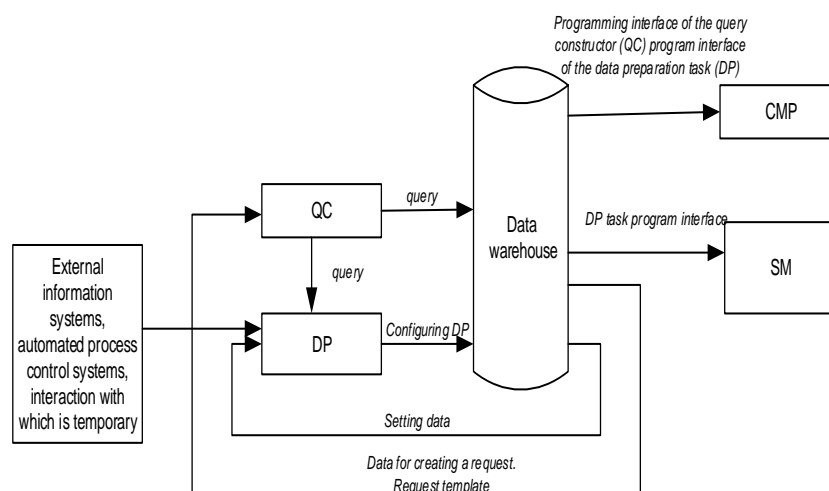
### 2.3. The link with simulation modeling (SM) and other modules

DP module provides an application programming interface (API) for calling a DP task by name. API is presented by DataPublish class. Using the identifier the caller needs to obtain the object of DP task from data storage and call the GetPublishedData method from it to get the execution results [6, 7].

Figure 3 shows the scheme of interaction with "Software module for models creation of technological, logistics and organizational (business) processes" (SMP) and "Software module for models integration with corporate information systems, MES and ERP-systems" (SM).



**Figure 3.** Algorithm of DP module operation.



**Figure 4.** Interaction of CMP and SM modules with DP module.

Figure 4 shows that data preparation tasks are created in the DP module. In these tasks, the MOD marks data flows needed to be passed to other modules. CMP and SM modules access this data via the application programming interface of data preparation tasks.

#### 2.4. The list of technical equipment

The list of used technical equipment is given in tables 1 and 2

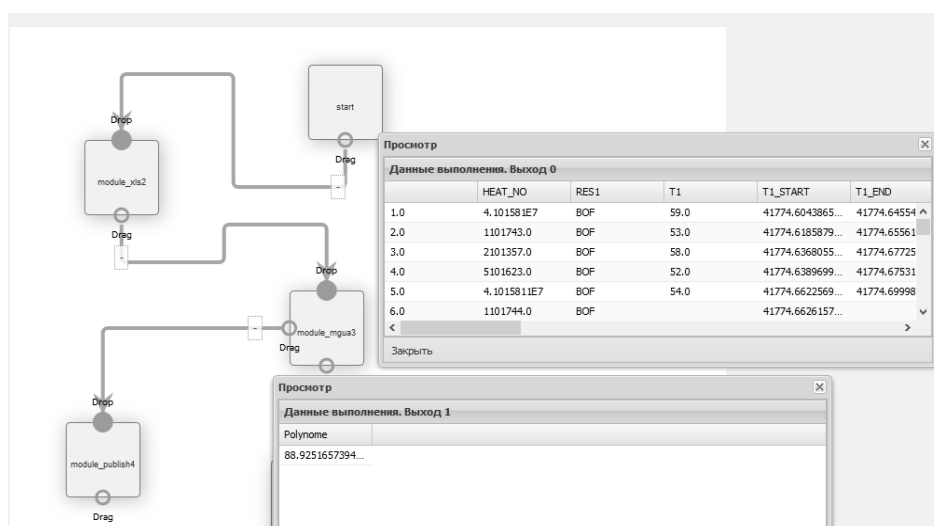
**Table 1.** The characteristics of QD module server.

Components	Quantity
IBM Bladecenter HS22V 7871B6U	1
Intel Xeon Processor X5660 6C 2.80GHz 12MB Cache 1333MHz 95w	2
16 GB (1x16GB, 2Rx4, 1.35V) PC3L- 10600 CL9 ECC DDR3 1333MHz VLP RDIMM	16
IBM 50GB SATA 1.8" NHS SSD	2

**Table 2.** The characteristics of server disk subsystem of QD module.

Components	Quantity
SAS HDD 15k 450GB	8
SSD 300GB	6
FChostbusadapter (HBA) IBM	1

Figure 5 shows a fragment of DP module interface in data view mode.



**Figure 5.** DP module interface in "Data view" mode.

### 3. Conclusion

The authors describe DP module of AS MPP consisting of two automated information systems an automated information system for data collection and analysis, as well as an automated information modeling system of technological, logistics and organizational (business) processes of the enterprise as

a whole. The given module provides data obtaining from heterogeneous sources (automated control systems, MES, ERP systems) as well as converting them into a convenient form for subsequent storage, setting conversion rules and output of heterogeneous data relevant to the query.

### Acknowledgements

The work was performed under an agreement with the Russian Foundation for Basic Research No. 19-37-90049 \ 19 of 08/27/2019.

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